Advanced RF Mapping (RadioMap) Phase 3
Proposers Day Workshop

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BAA Overview

BAA 15-07 – Advanced RF Mapping (RadioMap) Phase 3

Announcements

BAA was posted to www.fbo.gov on December 18, 2014

Schedule

- Proposers' Day: 6 January 2015
- Questions Due: 9 January 2015
- Proposal Due Date: 13 February 2015
- BAA Closing Date: 17 June 2015

Administrative, technical, or contractual questions should be sent via email to DARPA-BAA-15-07@darpa.mil

BAA-15-07 and associated amendments will be the official documents for this solicitation. They supersede statements made here.

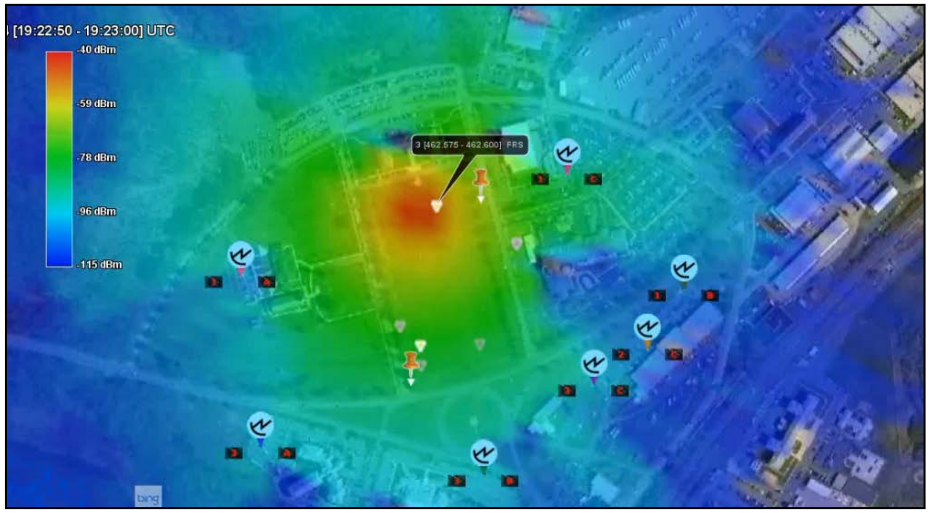
RadioMap Program Overview

RadioMap goal: Universal RF situational awareness

Exploit existing assets for Radio Frequency (RF) situational awareness

Use tactical radios and jammers as a sensor net

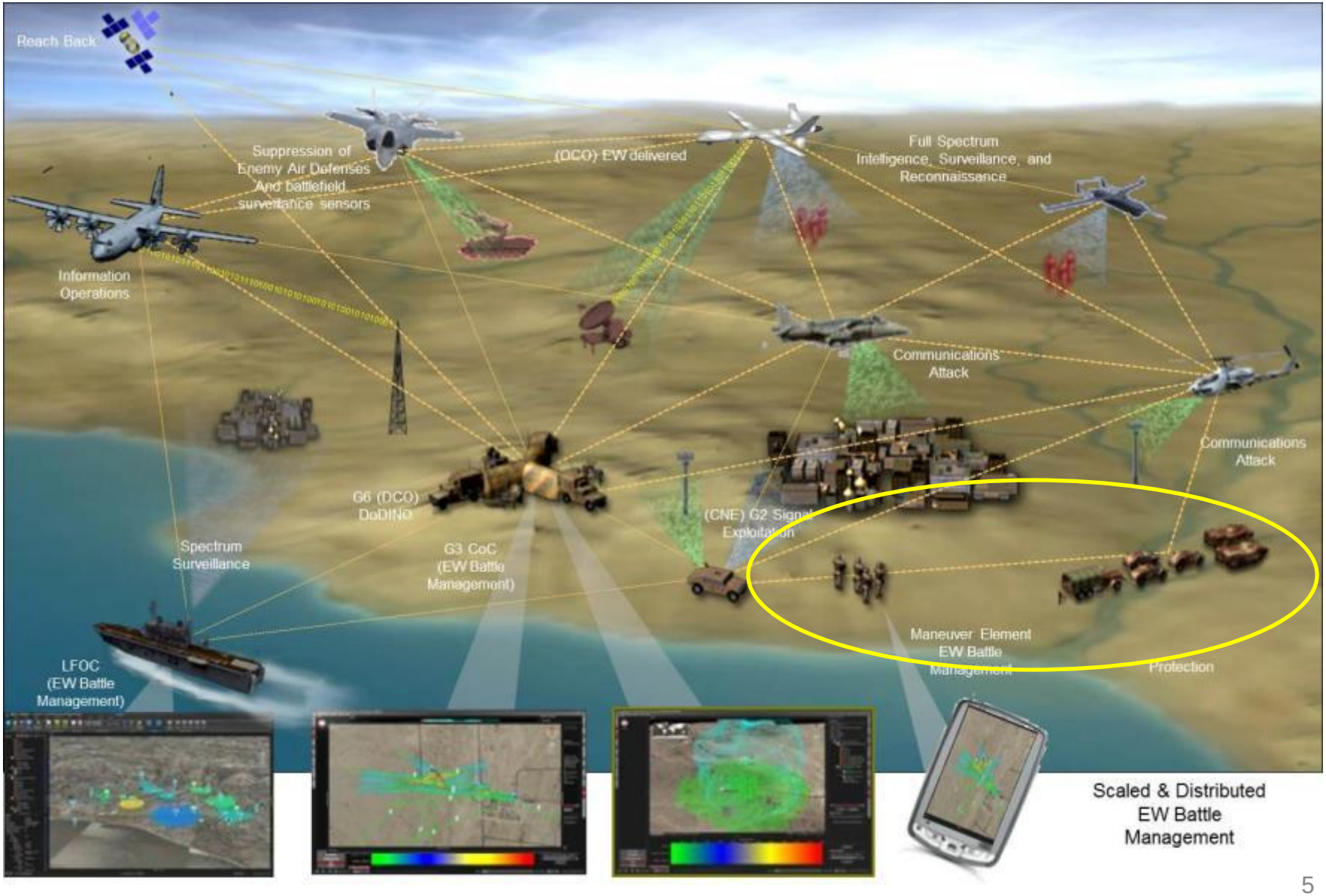
RadioMap software
No additional hardware



Heat map: Colors represent RF power level

Impacts
- Real-time Electromagnetic Spectrum Operations and spectrum management
- Night-vision goggles for the spectrum

Marine Air-Ground Task Force (MAGTF) OV-1 for Electromagnetic Spectrum Operations (EMSO)



RadioMap deployment

DARPA Funded Effort

Vehicular Radio

CREW Jammer

COTS Sensor

Battle Command Laptop

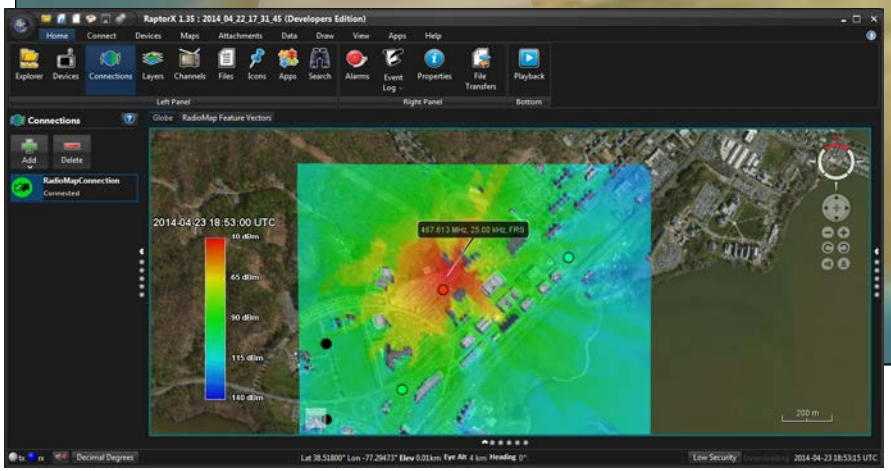
Cyber/EW Coordination Cell (CEWCC)

Mounted Unit

Dismounted Unit

RaptorX Visualization Tool

SPEED Spectrum Management Tool



Future Vision

Handheld Radios

Dismount Data Devices, e.g. JBC-P

Aerial Layer

EW & Software Defined Payloads

RadioMap software: a system-of-systems approach

User Interface Software

Data Fusion Software

C2 of RadioMap Network

Software for Field Assets

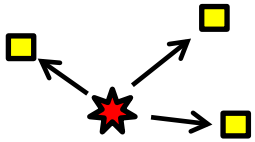
Heterogeneous
RF applications
- RF Mapping
- Tactical Alerting
- Others

Heterogeneous RF devices
Heterogeneous tactical networks

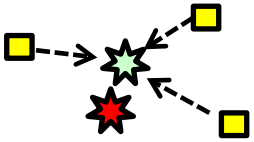
Interface To USMC Electronic Warfare Services Architecture (EWSA) Service Bus

Capabilities and Limitations of RF Mapping

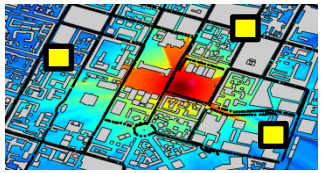
RF Mapping Implementation



1. Devices measure power



2. Estimate emitter location / power
   - Accuracy sufficient for EMS operations
   - Cue specialized systems to precisely locate emitter



3. Propagate forward to produce map
   - Report signal power / duty cycle / signal type
   - Cue specialized systems to intercept content

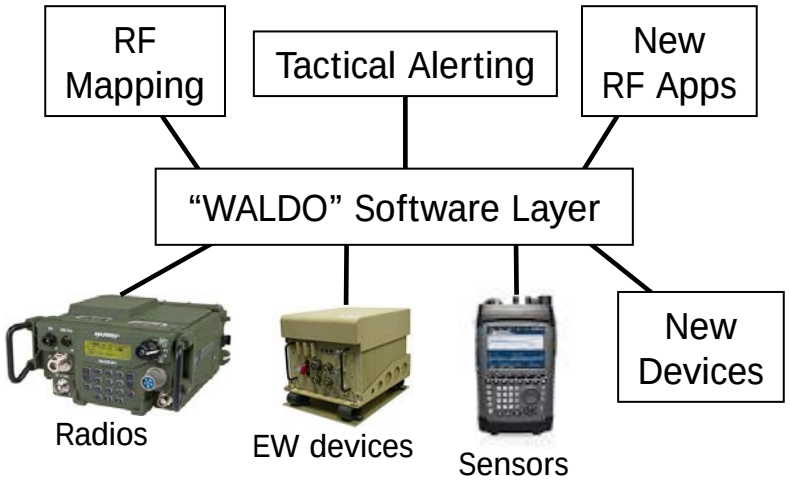
New capabilities

- Handle complex urban areas
- Real-time operation
- Cover space and time

RadioMap architecture

RF Mapping
- Detailed maps of RF spectral usage
- For Electromagnetic Spectrum Operations (EMSO)

Tactical Alerting
- Alerts on Signals of Interest
- Provide Bearing & Range
- For Small Unit Operations



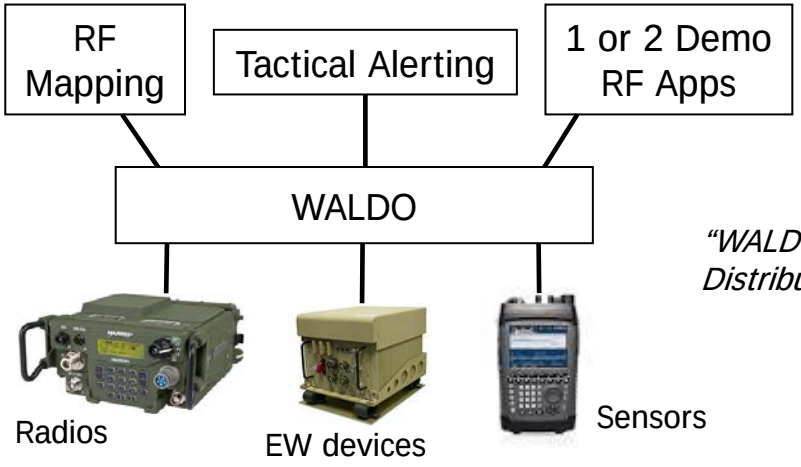
WALDO – Wireless And Large-Scale Distributed Operations
- Solve problems faced by any app that wants to use existing RF devices
  - Track device location & status
  - Automatically assign tasks to devices
  - Protect existing functions of devices and network
  - Modularization for rapid evolution of apps and devices

RadioMap Development

	RF Mapping	WALDO	Other RF Apps
Phase 1 2013	RF Mapping 	Architecture Design	Studies
Phase 2 2014	RF Mapping 	WALDO 	Studies

Phase 3

2015 Software Development
2016 Tests, Exercises
2017 Transition to USMC



"WALDO" – Wireless And Large-scale Distributed Operations

Phase 2 RadioMap Performers

Task	Organization	Project Title
RF Mapping	Argon ST	S5: Situational Scalable Awareness from Sparse Sensing
	Leidos	SPECTRE
WALDO	Advanced Communications Sciences (ACS)	MARTI
	Raytheon BBN	EMERSON
Studies of Other Applications	ACS	Precision Geolocation For RadioMap
	NAVSYS	DiNO-Pos: Navigation in GPS-Denied Environments
	Raytheon BBN	SPECTRA: Multistatic Radar
	Shared Spectrum Corporation	Counter Unmanned Aircraft Systems

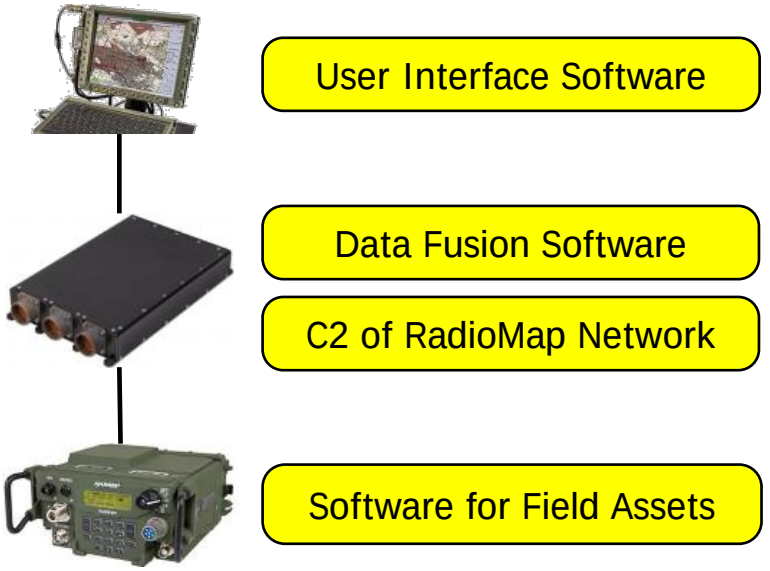
RadioMap Phase 3

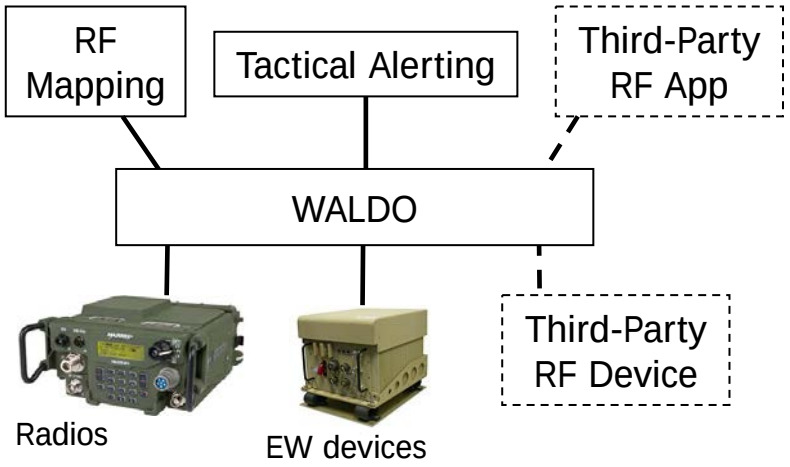
Phase 3 Overview

- **Task 1: RadioMap System**
  - Single award anticipated
  - 24 months
  - Develop an integrated RadioMap system suitable for transition to a US Marine Corps Program Of Record
- **Task 2: Airborne RF Sensors**
  - Multiple awards anticipated
  - 9 months base + 15 months option
  - Develop methods for utilizing data from sensors on low-altitude aircraft such as helicopters or UAS to improve RF mapping
- Future Tasks: (not solicited at this time)
  - **Third-Party RF Application and RF Device:** Use WALDO for a new application; integrate a new device into the WALDO network
  - Task 1 proposers interested in performing a third-party effort should ensure that staff who will be involved in proposing or performing the third-party effort(s) are **shielded from information about the Task 1 proposal and project** as of the release date of the BAA (December 18, 2014).

Task 1 Overview

- RadioMap system
  - RF Mapping Application and User Interface
  - RF Tactical Alerting System and User Interface
  - WALDO and User Interface
- Supporting Software and Documentation
  - Transition Roadmap
  - Training and Testing Environment
  - Manuals and Specifications
- Activities
  - Support Third-Party Application and RF Device
  - Tests, Demonstrations and Exercises





Task 2 - Airborne RF Sensors (1/2)

- Goal: Develop cost effective method of utilizing data from sensors on low-altitude aircraft such as helicopters or UASs to improve RF mapping.
- Challenge: Difficulty in resolving the spatial origin of an observed transmission in order to fuse it with data from ground sensors.
- Technology and Systems level Studies are sought
  - Technology studies: Innovative approaches that are applicable in systems where the airborne sensors have omni-directional antennas, such as innovative signal processing and data fusion techniques.
  - Systems studies:
    - Performance and Cost comparison of solutions limited to omni-directional airborne antennas, versus solutions that incorporate directional airborne antennas.
    - Encouraged to incorporate a technology study as described above.
    - Research on antenna technology is discouraged
    - SWAP (Size Weight and Power) and integration costs for deployment of the selected antenna(s) on USMC airborne platforms or UAS are key issues to incorporate in the cost side of the analysis.

Task 2 - Airborne RF Sensors (2/2)

- Task 2 Schedule:
  - Base effort is nine months in duration
  - Desire a costed option for a subsequent 15 month effort to implement and demonstrate the capability.

- Relationship to Task 1 proposers
  - If the Task 2 proposer is a member of a Task 1 proposal team, it is desirable for the option effort to integrate the proposed capability into the Task 1 RF Mapping application, and to demonstrate it at the final Phase 3 demonstration.

- Proposers are encouraged to provide a report no later than 30 days before the end of the nine month base effort, providing sufficient information for the Government to determine whether to exercise the proposed option.

Phase 3 Proposed Master Schedule

	2015								2016												2017						
	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J
	Contract award		**O Specification**			**WTI, Focus Grp**			**Map Test 1**			**WTI**	**TAS Test 1 Focus Group**			**Map Test 2**		**TAS Test 2 Bold Alligator**			**Infantry Course**			**Final Demo**			
Task 1	◆		O																						◆		
RF Mapping						★			★			★		■		★			★					★			
RF TAS													★	■				★				★		★			
									O Draft Report																		
Task 2	◆								O	◆														★	◆		
Third-Party App & Device (Anticipated)										◆														★	◆		

Task 1 Proposers are encouraged to adapt this schedule as appropriate to their research plan.

RadioMap Phase 3 Task 1
Detailed Discussion

Transition Roadmap

- A living document to be updated and consulted throughout Phase 3.
  - Audience: USMC organizations

- Work on the transition roadmap should **start early** in the research effort and should **provide major input** to the technical work and the design of tests and exercises.
  - Tactics techniques and procedures (TTP) applicable to RF Mapping, RF TAS, and WALDO for operational use by each of the three identified user communities.
  - Other items (see BAA)

- Accreditation is not expected during RadioMap Phase 3 except as required for participation in USMC exercises.

System and device issues

- System Level Issues
  - Provide a useful capability on stressed tactical data networks
    - Minimize network load
    - Tolerate intermittent connectivity
    - Provide the most useful results given available network resources
  - Secure operation in a high-threat tactical environment
    - Software architecture
    - Protocol design
    - Certification strategies
- Selection of RF Devices
  - Widely deployed or expected to be
    - Mounted or dismounted tactical radio.
    - System supporting EMSO, e.g. a mounted or dismounted CREW device.
    - A dismount capable data device
  - Maintain primary mission while operating as part of RadioMap system
  - Minimum 2 distinct devices

RF Mapping Application

- Phase 2 developed and demonstrated a baseline capability

- Research in the following additional areas is requested:

  1. Maximization of RF mapping performance under conditions of randomly changing network link and sensor availability.
  2. Detection, geolocation, and efficient implementation of queries for real-time and historical instances of, signals of interest within the sensor field.
  3. Capability to perform RF mapping at reduced accuracy in situations where prior RF measurements of the environment are lacking, or building data are lacking, or both. Capability to improve RF mapping accuracy over time by employing measurements gathered during operation.
  4. Use a database capable of scaling to large amounts of stored spectrum information to support historical queries and streaming playback simultaneously with ingestion of new spectrum information.

“Availability” refers to slow time, not fast time

- Slow time: periods where WALDO cannot operate >= target signal duration
- Fast time: periods where WALDO cannot operate << target signal duration
  - For Phase 3 testing, target signal duration > 3 seconds.

- Slow time example
  - A single channel radio
  - TX for 3 seconds of every 10 seconds
  - During TX no WALDO functions occur
  - **This device is considered 70% available**

- Fast time example:
  - TDMA radio
  - One slot dedicated to WALDO
  - 5 mSec out of every 150 mSec
  - **This device is considered 100% available** (even though WALDO only gets 3.3% duty cycle)

RF Mapping Tests

- Test 1 (8-12 months after award):
  - On dedicated sensors:
    - Exceed Phase 2 metrics for completeness, accuracy, latency
    - Provide alerts and geolocation of signals of interest
  - Simulate periods of device and network unavailability
    - Measure degradation at 30%, 50%, 80% random unavailability
  - Measure performance when detailed previous information about propagation is lacking
    - Measure improvements as system “learns” propagation environment
- Metrics for degraded operation to be established after Test 1
- Test 2 (roughly 6 months after Test 1):
  - Assess performance under degraded conditions against agreed metrics
  - Support 3 users simultaneous with ingestion of new spectrum data
  - Large (1 TB) database

RF Mapping Demonstrations and Exercises

- Oct 2015: USMC Weapons Tactics Instructors course
  - May use Phase 2 RF Mapping code base (without WALDO)
  - May use COTS sensors
  - Provide data to standalone user interface
  - Focus group with warfighters to collect feedback

- April 2016: USMC Weapons Tactics Instructors course
  - Use new Phase 3 RF Mapping code base, including WALDO
  - Sensors are tactical RF devices deployed to support this demonstration
    - Ideally co-located in warfighter vehicles
  - Provide information to display platform shared with other data feeds
  - Goal: enhance mission success of CEWCC EMSO staff

- November 2016: USMC Bold Alligator exercise
  - Operate on tactical devices belonging to, and used for mission purposes by, USMC units participating in the exercise

- April 2017: Final demonstration at Quantico

Proposers are encouraged to adapt this schedule as appropriate to their research plan.

RF Tactical Alerting System (RF TAS) Application

- Generate alerts for spectral events of interest
  - Alerts should include Line of Bearing and range from the centroid of the sensors
  - Line Of Bearing within ±45 degrees
  - Range binned into one of three categories: < 200m, 200m–1km, > 1km
- User interface design usability and minimization of false alarms are important areas of research.
  - The application should be able to operate in units disconnected from higher echelons
  - should also be able to leverage higher echelon resources such as filtering of potential threats by intelligence organizations when connected.
- Tests, demonstrations and exercises begin 12 months after award
  - Later than RF Mapping because technology is less mature

Phase 3 Proposed Master Schedule

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Task 2	◆								O	◆														★	◆		
Third-Party App & Device (Anticipated)										◆														★	◆		

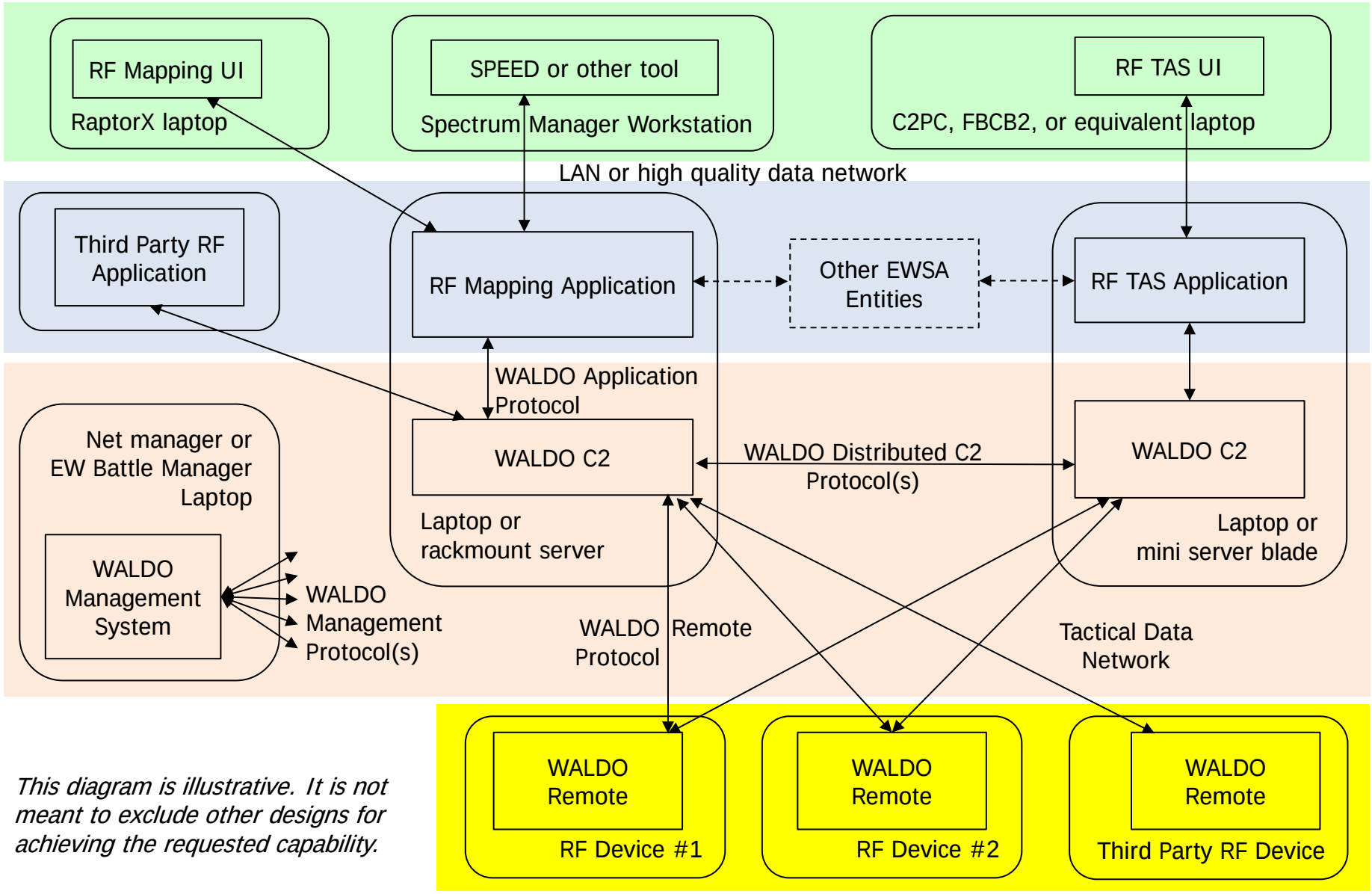
Task 1 Proposers are encouraged to adapt this schedule as appropriate to their research plan.

WALDO and user interface

- WALDO
  - C2 component:
    - Structured and documented to facilitate use of WALDO by new RF applications developed without participation by the Task 1 performer team.
  - Remote component:
    - Enables applications to remotely specify logic and computation to be performed on RF devices, to reduce network load.
    - Structured and packaged with sufficient documentation to enable a device vendor to port it to a new RF device without participation by the Task 1 performer team.
    - **The delivered release should be free of Intellectual Property (IP) restrictions other than readily available COTS software licenses.**

- WALDO Management System
  - Planning, configuration, prioritization, monitoring, troubleshooting
  - Monitor a large WALDO network (~100 nodes) in near-real-time, **including visualization of sensor location, status, and the assignment of tasks for particular applications**.
    - See BAA metrics for baseline overhead and overhead when visualization is operating.

RadioMap System components and relationships



This diagram is illustrative. It is not meant to exclude other designs for achieving the requested capability.

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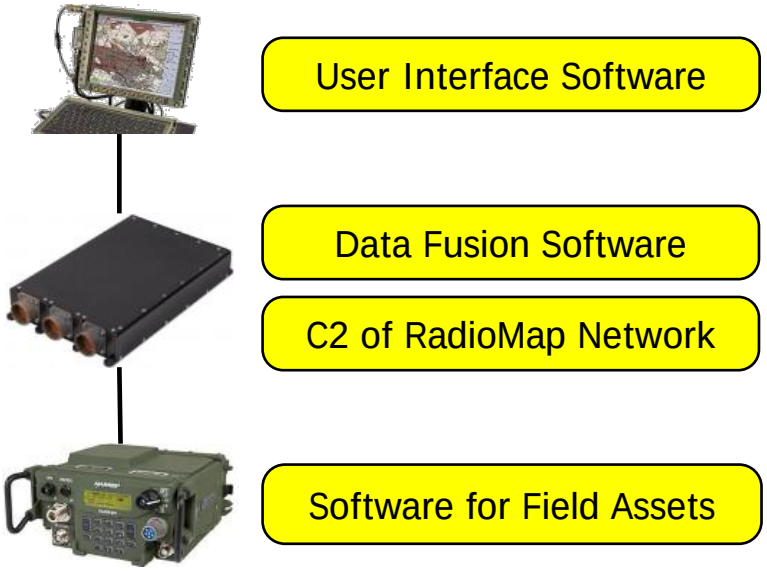

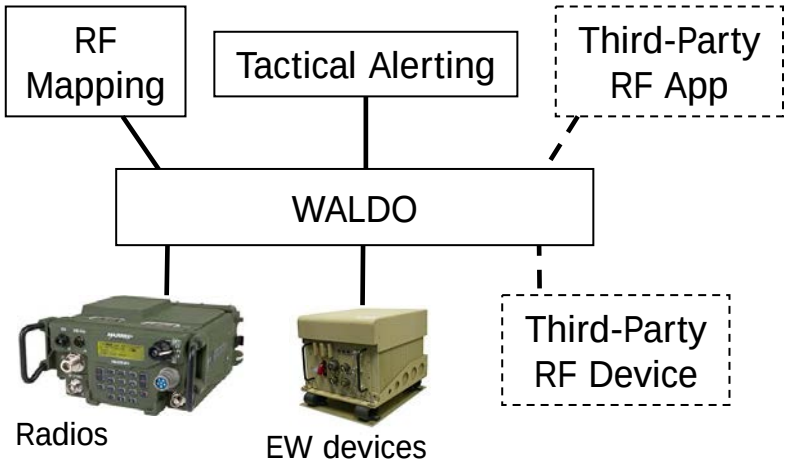

Government-Furnished Information, Equipment, Support

Government-Furnished Information (GFI) & Equipment (GFE)

- BAA Addendum is available with information from Phase 1 and 2
  - Addendum is ITAR restricted

- Post-Award GFI/GFE Provided to selected proposer(s)
  - Software and data from Phase 1 and Phase 2
  - Information from ongoing research that occurs in parallel with the proposal process
  - Sensor nodes acquired under Task 1 efforts in RadioMap Phase 1 and Phase 2.
    - approximately 100 RF receiver sensor nodes of several types
    - Supporting equipment (laptops, antennas, power supplies, etc.)

- DARPA does not anticipate providing tactical RF devices as GFE for Phase 3, except as described in Section 1.4.10 exercise guidelines.

Government-Furnished Support (1)

- AFRL Rome Laboratories
  - Contracting agent and COR

- Johns Hopkins Applied Physics Laboratory
  Roberson & Associates
  Institute for Defense Analyses
  - Design and evaluation of DARPA tests

Government-Furnished Support (2)

- SPAWAR Systems Center Pacific Field Experimentation Team (SSC PAC FET)
  - FET introduces users to new techniques and technology within realistic operational environments while providing user feedback to the S&T, academic, and acquisition communities.
  - FET will be the communications and coordination liaison to the Marine Corps for RadioMap Phase 3 demonstrations and exercises.
  - FET will:
    - Plan, coordinate and conduct Focus Group Workshops with warfighters.
    - Plan, coordinate and conduct Demonstration events and Exercise events.
    - Assist the RadioMap technical team in collecting operational user feedback.
    - Assist in and document assessment design and implementation.
    - Gather and document feedback from Marines to assist in the development of TTPs and Concept of Employment that exploit the technology capabilities in an operational environment.
    - Coordinate the shipment of equipment from and to sponsor.
    - Assist in the setup and installation of equipment.

Government Furnished Support (3)

- Computer Systems Center Incorporated (CSCI)
  - Expertise in accreditation for gaining Authority To Operate (ATO)
  - Handled ATO for USMC Electronic Warfare Services Architecture capabilities at recent Weapons Tactics Instructor (WTI) events
  - DARPA anticipates funding CSCI in CY2015 to support the Task 1 performer's demonstration at Fall 2015 WTI
    - Consulting with SMEs
    - Assist in preparing Certification & Accreditation packages
    - Produce additional Information Assurance (IA) documents as required
    - Coordinate meetings with the Certification Authority & expedite process
    - Onsite IA support during demonstration
  - **Funding to CSCI Is Not Yet Confirmed**

- DARPA does not anticipate funding CSCI beyond Fall 2015 WTI
  - Task 1 performer has responsibility to acquire necessary approvals for later events

Evaluation of Proposals

Overview of Evaluation Criteria

- Proposals will be evaluated using the following criteria, listed in descending order of importance:
  - 5.1.1 Overall Scientific and Technical Merit
  - 5.1.2 Plans and Capabilities to Accomplish Technology Transition
  - 5.1.3 Cost Realism and Schedule Realism
  - 5.1.4 Potential Contribution and Relevance to the DARPA Mission.

5.1.1 Overall Scientific and Technical Merit

- The proposed technical approach is feasible, achievable, complete and supported by a proposed technical team that has the expertise and experience to accomplish the proposed tasks. Task descriptions and associated technical elements provided are complete and in a logical sequence with all proposed deliverables clearly defined such that a final product that achieves the goal can be expected as a result of award. The proposal clearly identifies major technical risks and clearly defines feasible planned mitigation strategies and efforts to address those risks. The proposal clearly explains the technical approach(es) that will be employed to meet or exceed each applicable program goal and system metric listed in Section 1.7. Other factors to be considered will include the structure, clarity, and responsiveness to the statement of work; the quality of proposed deliverables; and the linkage of the statement of work, technical approach(es), risk mitigation plans, costs, and deliverables of the prime contractor and all subcontractors through a logical, well structured, and traceable technical plan.

5.1.1 Overall Scientific and Technical Merit
Specific Factors To Be Considered In Task 1 Proposals

- The proposed project achieves as many of the desired outcomes listed in Section 1.4 as possible. For outcomes where there is technical risk, the proposal clearly identifies the risks and explains the approach(es) that will be employed to achieve those outcomes, **in particular for the additional RF Mapping, RF TAS and WALDO capabilities that go beyond what was demonstrated in Phase 2**.

- The **plan for preparing and executing USMC exercises** is feasible, achievable, complete, and supported by a proposed team that has the expertise and experience to accomplish the technical goals of the exercises under difficult field conditions while maximizing the learning from the exercises that feeds back into transition plan improvements.

- The proposer demonstrates an understanding of, has a feasible approach to overcome, and supports the work with a proposed team with the appropriate expertise for, the **specialized problems associated with a distributed software system** providing an integrated capability across heterogeneous existing networks and devices in a tactical environment.

4.3.1 Volume I, Technical and Management Proposal

- Section II. Detailed Proposal

- I. Explanation of Statement Of Work (SOW): For Task 1 proposals, if any of the requested activities, deliverables or topics listed in Section 1.4 of this BAA do not appear in the proposer's SOW, this section should list which items were omitted and explain the rationale for the omissions.

5.1.2 Plans and Capabilities to Accomplish Technology Transition

- The proposer clearly demonstrates its capability to transition the technology to the research, industrial, and/or operational military communities in such a way as to enhance U.S. defense. In addition, the evaluation will take into consideration the extent to which the proposed intellectual property (IP) rights will potentially impact the Government's ability to transition technology.

5.1.2 Plans and Capabilities to Accomplish Technology Transition Specific Factors To Be Considered In Task 1 Proposals

- The proposer demonstrates its **capability to transition the technology to the US Marine Corps**, including choice of personnel with appropriate experience, leveraging of existing USMC relationships, and a clear vision for USMC deployment and use of RadioMap technologies and capabilities in support of small unit operations, electromagnetic spectrum operations, and spectrum management.
- The proposer has **selected RF devices and networks** for use in tests and exercises that maximize the probability of successful transition.
- The proposal offers a **schedule of tests, demonstrations and exercises** that maximizes the probability of successful transition.
- The proposal offers **unlimited rights to the WALDO protocol specification**. The proposal offers to **deliver source code for the WALDO remote** with unlimited rights other than required readily available COTS software licenses.

5.1.3 Cost Realism and Schedule Realism

- The proposed costs are realistic for the technical and management approach and accurately reflect the technical goals and objectives of the solicitation. The proposed costs are consistent with the proposer's Statement of Work and reflect a sufficient understanding of the costs and level of effort needed to successfully accomplish the proposed technical approach. The costs for the prime proposer **and proposed subawardees** are substantiated by the details provided in the proposal (e.g., the type and number of labor hours proposed per task, the types and quantities of materials, equipment and fabrication costs, travel and any other applicable costs). The proposed schedule aggressively pursues performance metrics in the shortest timeframe and accurately accounts for that timeframe. The proposed schedule identifies and mitigates any potential schedule risk.

5.1.3 Cost Realism and Schedule Realism Specific Factors To Be Considered In Task 1 Proposals

- The proposer demonstrates the ability to leverage relevant prior RadioMap research to **commence software development quickly** after contract award.

- The proposed effort offers a realistic schedule for rapid software development and integration, including well-specified interim milestones, an effective approach for managing software development schedule risk, and a plan supported by a modular software architecture for **ongoing improvements in the RF applications and WALDO infrastructure** over the course of Phase 3 based on research and exercise results.

4.3.2 Volume II, Cost Proposal

- The prime contractor is responsible for compiling and providing all subcontractor proposals for the Procuring Contracting Officer (PCO). Interdivisional Work Transfer Agreements (ITWA) or similar arrangements are considered equivalent to subcontracts, in that cost proposals for the work to be done in other divisions must be included.

- All subcontractor proposal documentation must be prepared at the same level of detail as that required of the prime contractor. **Subcontractor proposals and ITWAs must include cost breakdowns and justification following the structure of (1)-(4) above, or the overall proposal may be considered nonconforming.**

5.1.4 Potential Contribution and Relevance to the DARPA Mission.

- The potential contributions of the proposed effort are relevant to the national technology base. Specifically, DARPA's mission is to maintain the technological superiority of the U.S. military and prevent technological surprise from harming our national security by sponsoring revolutionary, high-payoff research that bridges the gap between fundamental discoveries and their application.

Conclusion

- Thank you for your interest in RadioMap.

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